CIRCULAR No. 80.

United States Department of Agriculture,

BUREAU OF ENTOMOLOGY,

L. O. HOWARD, Entomologist and Chief of Bureau.

THE MELON APHIS.

(*Aphis gossypii* Glov.)

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NATURE OF ATTACK.

The melon aphis, or, as it is commonly known, the "melon louse," injures plants by piercing them with its beak and sapping their vitality. It occurs from early spring to late in autumn on melons and other cucurbits of all kinds, and on many other crop plants, and in seasons which favor its increase, notably in summers following springs that are cool and rainy, it frequently develops in enormous numbers and does very serious damage, collecting in masses on the under surface of the leaves of plants and causing them to curl, shrivel, and lose color, and interfering with the ultimate development of the fruit. Often it kills plants outright, and destroys whole fields or greatly reduces the yield of fruit. An affected cantaloupe plant is illustrated by figure 1.

The melon aphis, like others of its kind, excretes "honey dew," but this is not so copious as in the case of many species of aphides, for example, certain forms which affect trees. When, however, the aphis under discussion becomes unusually abundant, the honey dew covers the leaves of the affected plants with a thin, sticky coating on which the white cast skins of the aphides adhere, and this attracts attention to injury, as does also the wilting and dying down of the plants. Some persons notice this honey dew, and are unaware of the presence of the insects. They speak of the injury as "honey dew," and have even applied this name to the insect itself.[a]

Quite too frequently, by the time the presence of the melon aphis in injurious numbers is noticed, irreparable damage has been accomplished and the insects have for the most part migrated to other pastures.

[a] Attack by many forms of aphides, especially those which excrete honey dew more copiously, can be readily detected by the presence of insects which feed on the sweet excretion. Among these are flies, wasps, bees, and especially ants. The melon aphis, however, is not an especial favorite with ants, altho some common species are occasionally found in attendance upon it. The pavement ant (*Tetramorium cæspitum* L.) is the only species which has thus far been observed by the writer, and neither ant nor aphis appears to be in any way dependent on the other for its existence, contrary to that which is the case with many other aphides, particularly those which have root-feeding forms.

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DESCRIPTION.

The melon aphis is a minute, soft-bodied creature, of variable color, usually of some shade of green or greenish black; in its young and wingless stages, louselike in appearance; and of sluggish habit thruout its existence. The general appearance of this species in its most commonly observable stages is indicated in figure 2, highly magnified. A brief description of the stages figured will suffice for the present purpose.

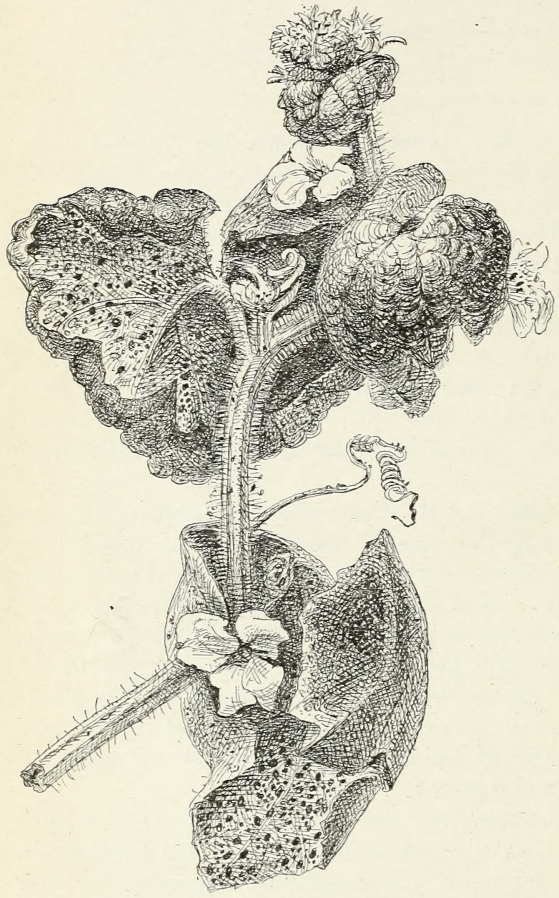

FIG. 1.—Cantaloupe leaves showing curling caused by melon aphis; aphides on lower surface. Slightly reduced (original).

The egg has been described by Mr. Th. Pergande[a] as of regularly oval shape and measuring about 0.6^{mm} in length; yellowish or greenish when first deposited, soon changing to jet black.

The larval aphis or nymph (fig. 2, *b*) when first born or hatched presents no observable characters for comparative description. It measures less than 0.5^{mm} and is pale in color, turning later to yellow. The last nymphal stage, corresponding to the pupa of other insects, is sufficiently illustrated at *c* that it requires no verbal description. The apterous or wingless female, which is viviparous (giving birth to living young), is figured at *d*. Great variation is exhibited in this stage, from pale yellow to very dark green, with black nectaries or honey tubes and pale whitish-yellow legs and antennæ. This stage varies in length from 1.5 to 1.8^{mm}. The winged female is illustrated at *a*, which shows a form with pale abdomen. The body is more slender than in the wingless form, the length being

[a] Insect Life, Vol. VII, pp. 309–315, 1895. Technical descriptions are furnished also by Forbes, 12th Rept. St. Ent. Ill. f. 1882 (1883), pp. 83–91.

from 1.2 to 1.8^{mm}, while the wings expand from 4.5 to 6^{mm}. A darker form of the female is shown in profile at *ab*, and the antennæ, much enlarged, at *aa*. The male has not as yet been recognized.

This is by far the most important and abundant aphis affecting melons and other cucurbits, and is not likely to be confused with any other species occurring habitually on the same class of plants.[a] It is, indeed, a very important pest, and, taken season after season, the worst aphis occurring in this country.

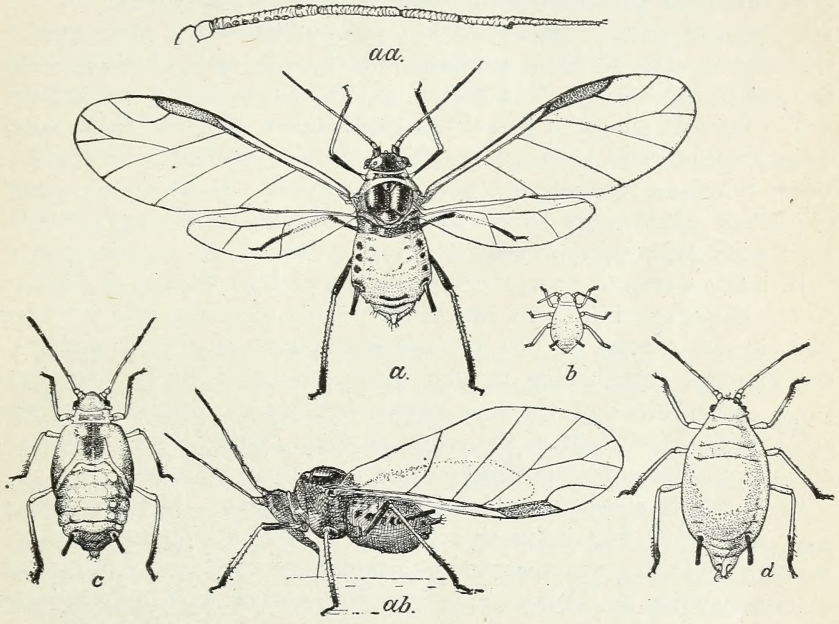

FIG. 2.—Melon aphis (*Aphis gossypii*): *a*, winged female; *aa*, enlarged antenna of same; *ab*, dark female, side view, sucking juice from surface of leaf; *b*, young nymph or larva; *c*, last stage of nymph; *d*, wingless female. All greatly enlarged (author's illustration).

DISTRIBUTION.

The origin of the melon aphis is doubtful, but is probably tropical, since this insect shows a decided preference for plants of a tropical nature, such as the cucurbits, cotton, and orange. Southward the aphis occurs in the West Indies, in Mexico, and in Brazil, and doubtless elsewhere in South America. It is very generally distributed thruout the United States, but does more injury in the southwest than elsewhere. In Texas, Kansas, and Nebraska it is particularly troublesome to melons, and in the last two States to cucumbers, which are there extensively grown for pickling. But it may at any time create

[a] The squash aphis (*Nectarophora* [*Siphonophora*] *cucurbitæ* Middleton), a much larger species, more uniformly green, and of a much lighter and brighter color, is often found on cucurbits, but seldom in sufficient numbers to cause noticeable damage.

more or less trouble in northern regions, particularly in Virginia, Maryland, Delaware, and New Jersey, where cucurbits are much cultivated. Occasionally it is injurious as far north as Minnesota and west to California. It has been collected also in Adelaide, South Australia.

INSTANCES OF INJURY.

The melon aphis first attracted notice thru its injuries to cotton in 1854, and from that time on it has done more or less damage year by year, and, in view of its rapacity, rapid multiplication, and omnivorous habits, will no doubt continue injurious in spite of all that can be done to repress it. As a melon and cucumber pest it was noticed in Florida and southern Illinois in 1880, and in the next three years caused considerable losses in those States and in Georgia. Soon afterwards it became recognized as a strawberry pest. In later years many other food plants were added to its known dietary. The years 1892, 1893, and 1898 were unusually bad "aphis years."

In 1893 information was received from a pickle company of Omaha, Nebr., of severe injury in that State. This company was growing between 30,000 and 50,000 bushels of cucumbers a year, and several hundred neighboring farmers grew this vegetable for the company. Two-thirds of the crop grown in 1892 was destroyed by the aphis, and in 1893 half of the crop was lost. These injuries made it difficult to induce outside planters to grow for the company.

In 1898 this species was extremely troublesome. In order that a good idea of its destructiveness may be had, some reports are cited. In January injury was reported on cucumbers in Florida and in May to strawberries in Delaware, where the insects were described as "taking everything clean." By June this insect had been very injurious to watermelon in southern Texas, when it destroyed many acres of early vines. In July Texas correspondents reported the destruction of 1,000 acres of cantaloupes in one locality, and the outbreak assumed such proportions as to cause much newspaper comment. One company reported that the ravages of this pest had cost them $20,000, and that agriculturists of that section had sustained irretrievable loss. In November a Pennsylvania correspondent reported losses to cucumbers grown under glass, and in December this aphis resumed its ravages to cucumbers in Florida.

LIST OF FOOD PLANTS.

The insect here considered is the most nearly omnivorous of any known species of aphis. The list of plants upon which it has actually been found feeding shows great diversity, and future observations may add many more host plants.

It is partial to the plants that have previously been mentioned—melons and other cucurbits, cotton, okra, orange and other citrus

fruits, strawberry, and purslane—but it attacks also clover, beans, beets, spinach, tomato, hops, and pear, and several ornamental plants, including hydrangea, begonia, ground ivy (*Nepeta glechoma*), Acalypha, and morning-glory. From its abundance on some of these plants it has received a number of common as well as Latin synonymical names, the former including cotton aphis, orange aphis, cucumber louse, and cantaloupe louse.[a] It is frequently called also the "black aphis," especially in its occurrence in greenhouses. Mr. Pergande has found it feeding upon a large number of weeds, among which are shepherd's purse, pepper-grass, pigweed (Amaranthus), dock (Rumex), burdock (Arctium), dandelion, lambsquarters (Chenopodium), plantain, chickweed, button-weed (Diodia), mallow, dogwood (Cornus), and Jamestown or jimson weed (Datura).

Since these aphides are not at all particular as to their food, when they migrate from their favorite plants they start colonies on nearly any plant that chances to be in their line of flight. The writer has seen asparagus and violet attacked, the latter grown in greenhouses.

LIFE HISTORY.

Attack to cultivated plants begins from early spring till considerably later, and is made by winged individuals flying from weeds which serve as alternate food plants. Infestation naturally commences earlier in the South than northward, and may be simultaneous with the appearance of the crop above ground. Soon after the plants have developed leaves a few winged aphides can usually be found, and these are the forerunners of myriads to follow. As often as a plant becomes exhausted of its vital juices by the sucking mouth-parts of innumerable aphides, winged individuals are developed which migrate to other plants, so that migration in the case of this species is carried on practically thruout the season. Flight from one kind of food plant to another, or from one field to another, is caused also by disturbance from the abundant natural enemies of the insect. The great numbers of this species sometimes suddenly discovered on melons, cotton, orange, and other plants are often due to enforced migration on account of the death of other food plants in the vicinity, such as might be caused by atmospheric conditions, or by the ravages of the aphides themselves, or of other insects. The removal of the crop on which the insect was at work will produce the same effect.

NATURAL ENEMIES.

There is perhaps no better example, among insects, of a common and widespread species being held in abeyance and limited to innoxious

[a] The synonyms include *Aphis* (*Siphonophora*) *citrifolii* Ashm., *Aphis citrulli* Ashm., *Aphis cucumeris* Forbes, *Aphis forbesi* Weed. It is still mentioned in literature as *A. cucumeris*.

numbers (save in exceptional seasons) by natural enemies than the melon aphis. The usefulness of these natural enemies, of which a large number have been recorded, in subduing the aphides can not be overestimated. Garden and field aphides generally are subject to attack by the same classes of parasitic and predaceous enemies. The number of species of insects known to prey upon the melon aphis is about 35. The list includes many ladybirds or "ladybugs" (Coccinellidæ),[a] which destroy the aphis both as beetles and as larvæ; the maggots of certain syrphus-flies (Syrphidæ),[b] which consume large numbers of aphides; aphis lions—the larvæ of lace-wing flies, of the families Chrysopidæ and Hemerobiidæ.[c] A number of species of parasitic insects, chiefly minute forms of Braconidæ, are also very important checks on the increase of aphides.[d] Many, too, are destroyed by parasitic fungi.

The insect enemies of these, as of other aphides, keep their hosts, in many portions of the country and in ordinary seasons, in nearly complete subjection. The parasites, in particular, are most effective in dry, warm weather. In cooler, moist summer weather, especially following *the same atmospheric conditions in spring*, when vegetables subject to aphis injury are starting growth, these otherwise natural checks are less active, and the aphides, as a result, frequently gain the ascendency.

Some of the commonest species of ladybird enemies of this and other aphides are illustrated in figure 3. In the "aphis year" of 1898 the Scymnus (fig. 3, *h*, *i*, *j*) was particularly abundant in and near the District of Columbia on aphis-affected plants. A still more abundant and useful form of this class of insects is the convergent ladybird (*Hippodamia convergens* Guér.), shown in fig. 3, *a*, *b*, *c*. It is fre-

[a] *Hippodamia convergens* Guér. and *Cycloneda sanguinea* L. are prominent enemies, as are also *Megilla maculata* De G. (fig. 3, *d*, *e*) and *Coccinella 9-notata* Hbst. Other species are *Scymnus terminatus* Say, *S. caudalis* Lec., *S. cervicalis* Muls. (A), *Chilocorus bivulnerus* Muls., *Exochomus constristatus* Muls. (H), and *Hippodamia 13-punctata* L.

[b] Syrphus flies include *Syrphus americanus* Wied., *Allograpta obliqua* Say, *Baccha clavata* Fab. (*babista* Walk.), *B. lugens* Loew. (H), *B. cognata* Loew. (H), *B. fuscipennis* Say (A), and *Eupeodes volucris* O. S. An agromyzid fly, *Leucopis nigricornis* Egger, also preys on this aphis. Cecidomyiid enemies include certain undetermined species of Contarinia (Diplosis).

[c] Among the lace-wing flies are *Chrysopa oculata* Say, *C. plorabunda* Fitch, *C. albicornis* Fitch (A), *C. nigricornis* Burm. (A), *C. lineaticornis* Fitch (A), *C. attenuata* Walk. (A), *Micromus posticus* Walk., and *Hemerobius gossypii* Ashm. (A).

[d] Parasitic braconids include *Trioxys testaceipes* Cress., *Lysiphlebus gossypii* Ashm., *L. citraphis* Ashm., *L. cucurbitaphis* Ashm., *L. minutus* Ashm., *Lysiphlebus* sp., and *Pachyneuron* sp. A chalcis fly, *Stenomesius aphidicola* Ashm., has also been reared.

The species followed by (H) were observed attacking *Aphis gossypii* on orange trees in Florida by H. G. Hubbard, those marked (A) by Wm. H. Ashmead on cotton in Mississippi. The others are mostly well known, and have been observed by various persons, as well as by the writer.

quently mistaken for the parent of the aphides. Another very efficient enemy, the nine-spotted ladybird, is shown in figure 3, *f*, *g*.

One of the most abundant syrphus-fly enemies is illustrated by figure 4.

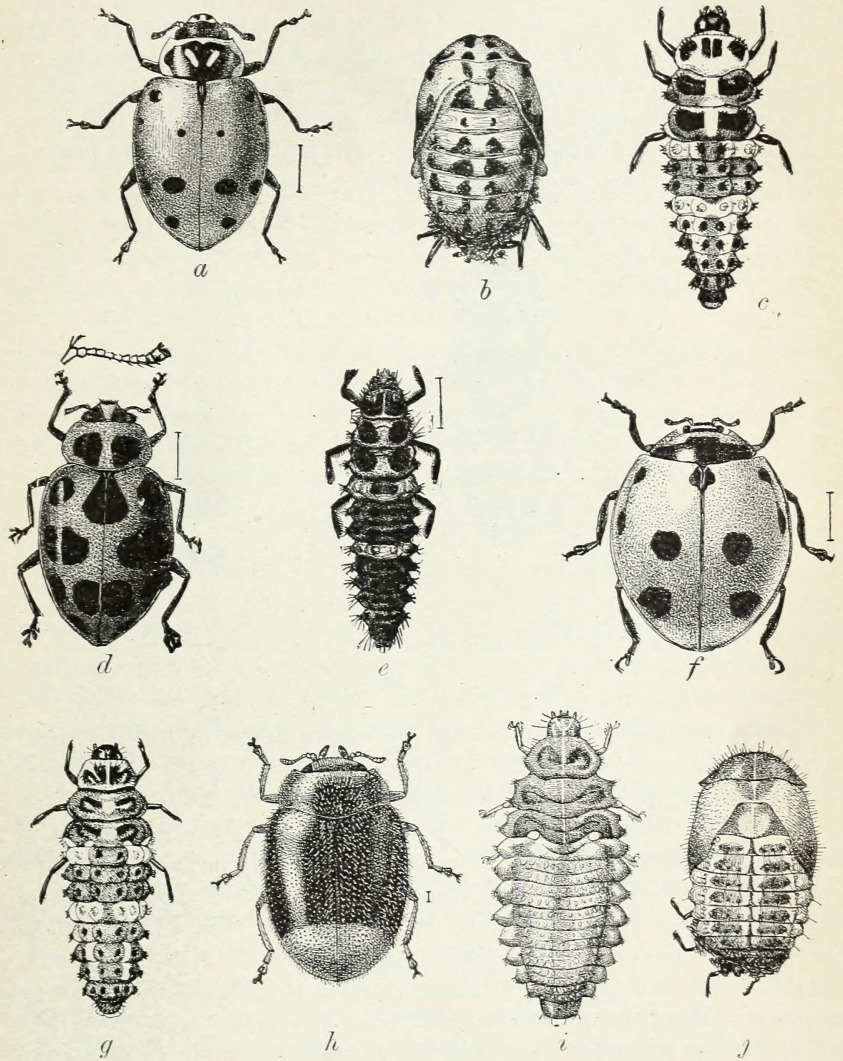

FIG. 3.—*a*, Adult of convergent ladybird (*Hippodamia convergens*); *b*, pupa of same; *c*, larva of same; *d*, adult of spotted ladybird (*Megilla maculata*); *e*, larva of same; *f*, adult of nine-spotted ladybird (*Coccinella 9-notata*); *g*, larva of same; *h*, adult of *Scymnus terminatus;* *i*, larva of same; *j*, pupa of same. All enlarged; size indicated by hair line at right (author's illustrations, *f–j* original).

Of the natural enemies which have been enumerated, ladybirds are particularly valuable, owing principally to the fact that they are active at all seasons, especially at the outset of aphis attack. Parasites are most effective toward the end of the season, when they often reduce

the aphides so that few are left to hibernate and produce other generations of the pest the following year.

The value of these natural enemies against aphides is such that entomologists frequently advise the employment of remedies only when the enemies are not present in abundance. The possible utilization of natural enemies in the field will be considered on pages 15 and 16 of this circular. In tobacco fumigation, which will presently be considered, we have an almost ideal remedy, for the reason that, while aphides are all destroyed, a considerable proportion of the ladybirds and other hardy beneficial insects, which are practically always present on the infested vines, survive this treatment.

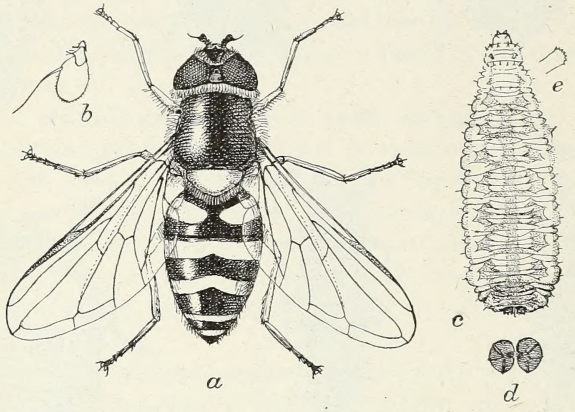

FIG. 4.—A syrphus-fly (*Syrphus ribesii*): *a*, fly; *b*, lateral view of head; *c*, larva or active immature form; *d*, anal spiracles; *e*, thoracic spiracle of same. All much enlarged (original).

METHODS OF CONTROL.

The severe losses occasioned by the melon aphis in its seasons of greatest destructiveness could be largely mitigated and in many cases almost entirely prevented if the employment of methods for its control were begun *upon the insect's first appearance*. For its successful treatment it is necessary to keep constantly in mind several of the facts that have already been given more in detail. In ordinary seasons the species is controlled by the combined operation of natural elements and insect enemies, but at times when the weather is unfavorable to the development of these enemies the grower should be on the alert. The presence of the aphides is often not detected until they are numerous, and even then they are not apt to be noticed unless the *lower* surface of the leaves be examined.

All things considered, the most satisfactory way of controlling this insect is by fumigation. As an aid, however, cultural methods are necessary. In the South spraying with kerosene and other emulsions is preferred to the bisulfid of carbon method, and tobacco is now much used, especially in Texas. The encouragement of natural enemies gives promise of success.

BISULFID OF CARBON FUMIGATION.

This treatment of the melon aphis has been used successfully for some time, and is valuable in small fields, but less profitable where cucurbit or other crops are grown over large areas. It consists in evaporating bisulfid of carbon under tubs, or similar tight receptacles, such as pails, buckets, or boxes. The chemical is employed at the rate of a dram (about a teaspoonful) to each cubic foot of space; a tablespoonful will serve for ordinary small tubs. This method of treating the plant does not injure it, and if the tub fit tightly to the ground, so as to retain the vapor of the bisulfid, all of the aphides which are covered will be killed. This method may be followed successfully in large fields if the grower be careful to watch the vines for the first appearance of the insects, and to treat such hills as require fumigation, removing and destroying plants that are badly affected to prevent the spreading of the insects to others.[a]

Caution.—In the use of bisulfid of carbon as a fumigant for aphides the usual precaution should be observed *not to expose the fumes to fire. The operators must not smoke during this process!* As the gas is heavier than air there is no danger, if ordinary care is observed, that the fumes will be inhaled by human beings.

HYDROCYANIC-ACID GAS TREATMENT.

This gas, as has been demonstrated by Prof. E. D. Sanderson, can be used in the field in much the same manner as the bisulfid of carbon, with wooden tubs or buckets. It has not, however, been adopted by growers and we do not recommend it. It possesses an advantage over bisulfid of carbon in that the cover used in gassing need not fit closely to the earth. On the other hand, it is *decidedly more dangerous to human life and must therefore be handled with the greatest care!*

As a greenhouse insecticide this gas is a perfect remedy for aphides and other small and soft-bodied insects. It is used where tobacco is unsafe; for example, in violet houses, violets being especially subject to "spot" after fumigation with tobacco. The method of applying hydrocyanic-acid gas is described in Circular No. 37 of this Office.

PYRETHRUM POWDER.

Pyrethrum or buhach insect powder, administered dry with a powder bellows to the lower surface of leaves, will kill the insects, altho these sometimes do not appear to be affected at first. A second or third application is sometimes necessary. This is an expensive remedy and can not be used with profit on large fields or on plants with large leaves, like squash.

[a] In New Jersey and Colorado many growers simply take out and bury such badly infested plants as are noticed when the hills are turned for cultivation.

FUMIGATION WITH TOBACCO PREPARATIONS.

Tobacco extracts and fumigating powders have been extensively used for a number of years by florists as fumigants against aphides and other insects occurring in greenhouses, such as white fly, thrips, and other small, delicate, and soft-bodied insects. The extracts contain a larger proportion of nicotine than ordinary decoctions prepared by steaming waste stems and powdered tobacco, and are therefore much more effective, which is true also of the powdered forms of nicotine. A number of these preparations are on the market and are advertised in the principal florists' journals and in other agricultural periodicals. They are used in various ways, and directions are furnished with the packages purchased. The liquid preparations vary in strength from 35 or 40 per cent up to 80 to 85 per cent nicotine.

FIELD FUMIGATION WITH TOBACCO.

During the years 1904 to 1906 the employment of tobacco or nicotine preparations in destroying the melon aphis in the field was the subject of experiment in Texas by Messrs C. E. Sanborn and E. D. Sanderson.[a] These have stated to the writer that, judging from their experimental use of this method and its practical use by extensive growers, it bids fair to become the best method of dealing with the melon aphis in its occurrence in the South. The process is in brief the fumigation of a dry preparation under a cloth-covered frame placed over the affected vines. In 1905 and 1906 the writer found that a very short exposure to tobacco fumes killed aphides, when other insects, such as thrips, survived a considerably longer treatment.

In practising this method Mr. Sanborn has used apparatus substantially as follows:

Preparation of the frame and cover.—For vines 2 or 3 feet long he advises a light frame 4 by 6 feet, supported by legs 8 inches in length. Lumber three-fourths inch thick and 2 inches wide is suitable. Strengthen the frames by connecting the ends with a crosspiece. Two diagonals are also used for strengthening the frame and for convenience in handling, the latter being attached after the cloth cover is in position. The cover is of muslin of a cheap grade (7 or 8 cents a yard) and sufficiently compact to prevent a passage of gas thru its meshes after being oiled. Its size should be about 2 feet wider and 2 feet longer than the frame which it covers. This is sufficient for an 8-inch wall and a 4-inch lap to the ground. Dirt is placed about the bottom to keep the gas from escaping there.

After the cloth has been cut and sewed into the sizes desired it is saturated in a vessel of linseed oil which fills the pores. It is then

[a] An experiment with tobacco smoke as a remedy for this species was made by Dr. S. A. Forbes in 1882. The result was not a perfect success, for the reason that a bee smoker was used and the smoke was blown under canvas hay caps covering the affected plants. Nevertheless from 50 to 75 per cent of the aphides were killed by 10 minutes' exposure.

wrung out, slightly dried, and placed over the frame and held in place by nailing the diagonals to the frame above the cloth. A gallon of linseed oil is sufficient for rendering four covers of the size above specified sufficiently air-tight for this method.

The number of frames for use depends upon the degree of infestation and the rapidity of the operators. Ordinarily about 10 frames are sufficient for one man's attention.

Method of application.—The frame is placed over the infested plant. One sheet of the fumigating preparation is torn into from two to four or more equal parts (according to directions on the package or as experience may decide) and each part is put in a tin fruit can under the frame near a corner and then ignited. The cans are perforated at the bottom by driving a large nail in at the side. It is well to use a long taper or fuse for lighting the fumigant, affording the more active beneficial insects time to escape from under the cover before the tobacco fumes are given off. Earth is then heaped on the border of the cloth on the ground to prevent the escape of the smoke. The frame should remain in position ten or fifteen minutes, or longer if preferred. Each operator should have enough frames to handle so that each frame in succession may remain on a vine during the time mentioned.

In localities where the aphis is most injurious local merchants who deal in insecticides should be informed of the fact and requested to keep a supply of fumigating preparation always in stock.

The best time for fumigating is when there is no wind and the vines are damp. In moderately dry weather, however, good results may be obtained.

Caution.—Care should be exercised not to allow the dry fumigant to ignite. It should smolder only. Vines should not be disarranged except where they protrude a few inches beneath the cover. The leaves should not touch the top of the cover.

Variations of the fumigating frame.—The frame described above has been used in the fumigation of young plants in southern Texas. The size and make-up of the frames may be altered or improved by the individual grower to adapt them to the size of the vines and the nature of the plant to be fumigated. Farther north than Texas manifestation of injury is not usually observable until the plants have made considerably larger growth, and a larger frame, say about a foot high, will be found more desirable for general use. Unbleached cotton of compact mesh, at 10 cents a yard, answered as well as the oiled "muslin" in experiments conducted by the writer, and there is a saving of time in its use. Moreover, it does not collect dirt nor soil the clothing and other objects with which it comes in contact.

For the treatment of plants other than cucurbits, such as cabbage affected by the cabbage aphis, eggplant, tomatoes, and other truck Mr. Sanborn advises a hood, using a frame made of two wires bent in a semicircle. Strong barrel hoops may be substituted, and the cover tacked to them at the top where they cross and at the bottom of the

hoops. Ornamental plants of low-growing sorts may be fumigated by means of such a hood, while for moderately high plants, such as roses, which are much affected by two common species of aphides, special covers may be constructed.

VAPORIZING AND FUMIGATING TOBACCO IN GREENHOUSES.

In the *vaporization* of tobacco—a practise which has been in use since about 1894 and which has largely superseded ordinary dry-tobacco fumigation in many sections—tobacco stems or dried tobacco, in one or another of its various proprietary forms, are placed in a kettle, metal pail, or similar receptacle. A hose is then connected with a steam pipe, the nozzle inserted in the receptacle, and the house to be treated becomes saturated with the vapor of tobacco, with the resulting destruction of aphides and other soft-bodied insects that may be present, such as thrips or "white fly."

Liquid preparations are more generally evaporated over alcohol or other lamps, or are placed upon steam pipes, or hot irons are put into the receptacles. For general greenhouse fumigation, fumigating powders are placed in shallow pans, and a few drops of kerosene are added to facilitate ignition. The dry fumigant is designed to burn slowly, so as to produce a smudge which, when dense, is fatal to aphides. This process of treatment may be applied at any time, by day or over night, and upon its completion the house is ventilated. In some cases the plants are syringed, but this is not necessary with plants like cucumbers. A surplus of moisture is to be avoided, owing to the liability of inducing "spot," mildew, and other fungous diseases on plants susceptible to such maladies.

The amount of a tobacco compound to be used depends upon its strength, the plants to be treated, and the size of the greenhouse. Several forms are for sale under different trade names. It is not probable that these differ greatly from one another in value, but there is much difference in their strength. They are put up in both dry and liquid forms.

In experiments conducted on greenhouse cucumbers at the Massachusetts Agricultural Experiment Station, at Amherst, one of these preparations has been used successfully at the rate of 5 or 6 teaspoonfuls to 1½ pints of water, and vaporized in a space of about 5,000 cubic feet. The length of exposure in this case was over night. Thus used, it does not injure delicate plants, like cucumber, but it kills all aphides and nearly all thrips—for which it was used primarily and which are not infrequently associated with aphides on the plants to be treated.[a]

[a] Thrips and "white fly" (*Aleyrodes* spp.) are more resistant to poisonous gases than are aphides. The former are most effectively destroyed while in the soft immature stages. The adult thrips are hardier and, being winged and more active, spring and fly away, and are thus not so easily brought in direct contact with insecticides like kerosene emulsion. The white flies, on the other hand, are more susceptible to poisons while in the active adult stage. The nymphs are of firmer consistency and comparatively resistant. Remedies for the greenhouse white fly are discust in Circular No. 57.

Tobacco in fine powder form dusted lightly on very young plants serves both as a repellent and as a mulch, or fertilizer. It is claimed by some to deter the striped cucumber beetle; others report that it is not effective for this beetle.

A successful fumigation or vaporization of a cucumber house infested with the melon aphis was made also in June, 1906, at Anacostia, D. C. A different preparation was used, and 66,000 cubic feet of greenhouse space was fumigated, 22 ounces of the liquid, or 1 ounce to 3,000 cubic feet, being employed. The work was under the writer's direction and conducted by Mr. I. J. Condit, with the cooperation of Mr. J. W. Bryan, owner of the house. At the end of an hour and fifteen minutes, when the ventilators were opened and the greenhouse aired, the aphides were found dead and dying, and the cucumbers were unharmed. Eight evaporators were used in this instance, each holding a little less than 3 ounces of the liquid. It is quite probable that a considerably smaller amount of the preparation, say 1 ounce to 5,000 cubic feet, with an all-night exposure, would have accomplished the same object. The cost of fumigation is not above $2.50 for a house containing 64,000 cubic feet.

Caution.—Before fumigating an entire greenhouse with any substance a preliminary test is always advisable to guard against accidents and to avoid waste of material. In the case of one liquid tobacco fumigant used at Washington, the preliminary test showed that, employed at the strength advised by the manufacturers (*i. e.*, without dilution), it ignited in the evaporating pan instead of vaporizing. This trouble was obviated by diluting the fumigant with half its amount of water, the further precaution being taken of placing a wire gauze beneath the pan and over the flame. In the case of some alcohol lamps used for this purpose the flame is apt to be too strong, especially if placed too near the evaporator. This causes the glass to break. Brass or other metal lamps are therefore preferable. Unless the lamps and wicks are of good quality and fit properly, the alcohol is apt to ooze out around the cork and burn on the sides of the lamp and thus, also, cause breakage.

As a general rule it is best not to fumigate in *bright* sunlight, and not when delicate foliage or flowers have globules of water on them.

SPRAYING METHODS.

Kerosene emulsion and soap solutions.—The melon aphis could be much more readily dealt with if it were not for its unfortunate habit of feeding on the under surface of leaves—which are often badly curled, as shown in figure 1—and for the further fact that in large fields, particularly late in the season when the leaves are large, the vines grow so closely together, frequently becoming interlaced, that spraying by ordinary means is impracticable. Underspraying is an absolute necessity, and a sprayer should be used fitted with an upturned elbow and a

nozzle of the Vermorel type to secure this effect. An elbow designed for this purpose is shown in figure 5.

Kerosene-soap emulsion, the standard remedy for aphides, is the best insecticide for spraying purposes, but various soap solutions are used both for the melon and pea aphides. They are diluted with 6 to 8 parts of water. The emulsion and soap washes are of particular value when the plants are small, as then the aphides can be more readily reached than when the leaves have grown to larger size; and, to repeat, if injuries are to be averted the insect should be checked on its first appearance, not alone on cucumbers, melons, squashes, or whatever the main crop may be, but upon all neighboring plants which may harbor the insect, including beds of strawberry or groves of orange trees.

Kerosene-soap emulsion is prepared by combining 2 gallons of kerosene, one-half pound of whale-oil soap, or 1 quart of soft soap, with 1 gallon of water. The soap is dissolved in boiling water and then poured while still boiling hot (away from the fire) into the kerosene. The mixture is then churned rapidly for about five minutes, pumping the liquid back upon itself by means of a force pump and direct-discharge nozzle throwing a strong stream. At the end of this time the mixture will have become of the consistency of thick cream. Properly prepared, an emulsion will keep almost indefinitely, and should be diluted only as needed for use. For most species of aphides the staple emulsion should be diluted with from 10 to 20 parts of water. In the preparation of kerosene emulsion a force pump is a necessity, since if not made according to directions a perfect emulsion is not formed. There is then danger of injury to the plants by the kerosene, as also useless waste. There is danger and waste, too, if the insecticide is not applied by means of a fine nozzle in the form of a *spray*, which should be fine and mist-like, or "like a fog," as some one has aptly exprest it. It should be sprayed only for a long enough time to cover the plants, otherwise the liquid forms into globules and runs off. Figure 6 illustrates the method of operating a knapsack sprayer so as to produce an underspraying.

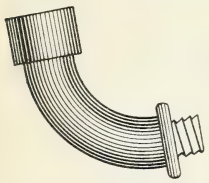

FIG. 5.—Elbow attachment for underspraying. Reduced.

Spraying with water.—Where a few plants only are to be protected, and it is possible to direct a strong stream of water upon them from a garden hose, syringe, or spraying machine, so as to wash off the insects, the aphis can be materially checked without the use of other materials. Such of the insects as come into direct contact with a stiff spray are unable to survive, while others that are dislodged from the plants do not succeed in returning. Many are wingless during the greater part of the season and unable to crawl any distance, particularly if the ground be dry and hot.

Cultural methods give greatest promise as remedies. Clean gardening or farming with fall plowing should always be followed, as these form a most valuable measure of prevention of injury by this and other insects that are present in the fields. As soon as the crop is off the remnants should be gathered and burned. All weeds in the vicinity should be kept down thruout the year, including late fall and early spring, since, as has already been shown, the common weeds of the field and garden are available as alternate food plants and serve as the hibernating quarters of the aphides, which feed more or less thruout the warmer periods of winter. On weeds the insects can be found feeding, in a climate like that of the District of Columbia, until January, "even after heavy frosts or snow," and again in March.

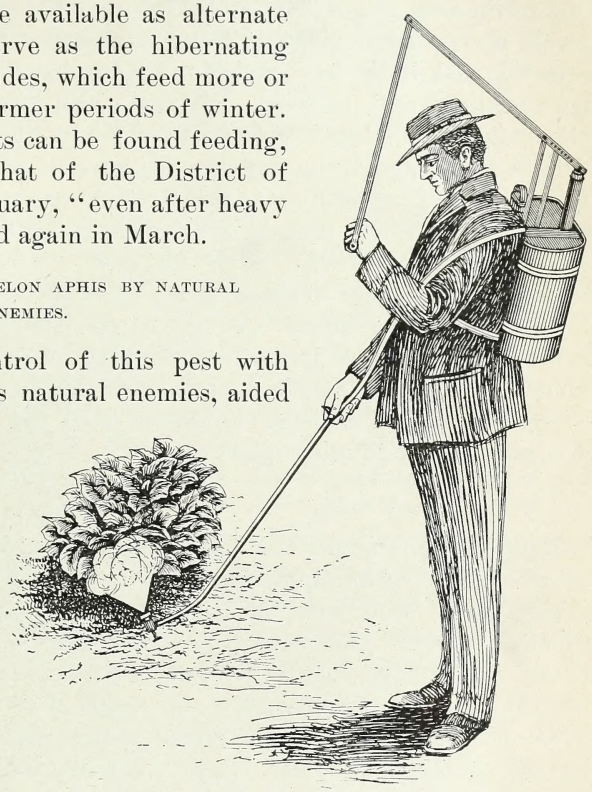

FIG. 6.—Knapsack sprayer in operation, showing method of applying underspray.

CONTROL OF THE MELON APHIS BY NATURAL ENEMIES.

The possible control of this pest with the assistance of its natural enemies, aided by a trap crop, is proposed by Mr. Sanborn, who has placed at the writer's disposal advance sheets of his publication in which this method is described.

Rape, which is of value for hog and sheep pasture, is the crop advised. Kale or mustard[a] should serve the same purpose. This method begins in the fall when the trap crop is planted.

The cabbage aphis (*Aphis brassicæ* L.) is closely related to, but quite distinct from, the melon aphis. It winters over on the trap

[a] For several years the writer has observed that these two crops serve as a trap for the cabbage aphis, by luring them from cabbage and more valuable crops; also, that they are here largely destroyed and practically held in check by their principal insect enemies—which have been illustrated in figure 3; and the idea of employing this means of attracting the natural enemies was suggested to the writer in 1900.

crop and attacks it early in spring, when, unless the natural enemies come to the fore, it multiplies in great abundance. In the writer's experience the ladybirds and other enemies soon gain the ascendancy and become so abundant that they are forced to migrate for food. The trap crop will ordinarily remain in condition to sustain aphides and their enemies until melons or other crops susceptible to melon-aphis damage have past the danger stage and are ripening.

The farmer may exercise his own judgment in regard to the location of the trap crop. The writer believes that the greatest advantage would accrue from planting three or more rows of rape or kale on each side and, in the case of fields of more than 4 or 5 acres, by planting additional rows between. Planted on all sides, the trap crop will attract aphides and their enemies from every direction, and this result will be facilitated by permitting the growth of weeds between the rows. In fact, weeds are a desideratum in these operations, since they furnish the best natural hibernating places for the ladybirds and similar beneficial insects. It is advisable also to place boards, loose bark, or hollow logs about the margins of the fields to secure better facilities for hibernation. As fast as one crop of rape, or whatever is used, matures, or its growth is stopt by the aphides (as might sometimes happen), another planting should be made so as to keep a constant supply of cabbage aphides on hand that the natural enemies may not migrate to other quarters.

CONCLUSION.

Many of the remedies that have been indicated as of service in the control of the melon aphis (with the exception of the last) operate against most other cucurbit insects, several species of which are usually present. Thus the kerosene emulsion and soap solutions kill young squash bugs and act as deterrents to most other insects, and bisulfid of carbon will kill other soft-bodied insects besides the aphides, while fall plowing and clean cultural methods are valuable in destroying the squash-vine borer. Tobacco fumigation, however, has little effect on these other insects as they occur in the field.

Approved:

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., *November 14, 1906.*

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